A simulation model of combined biogas, bioethanol and protein fodder co-production in organic farming

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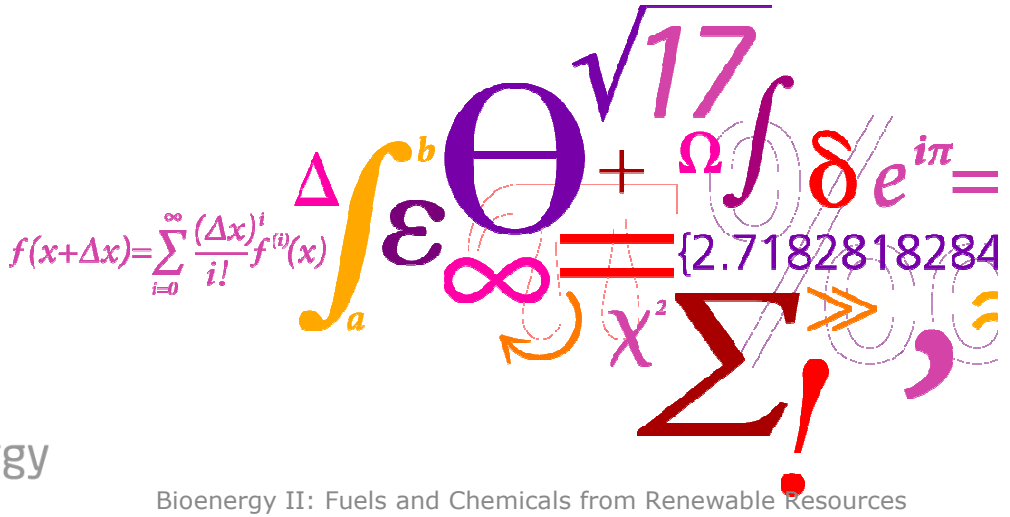

Risø DTU
National Laboratory for Sustainable Energy

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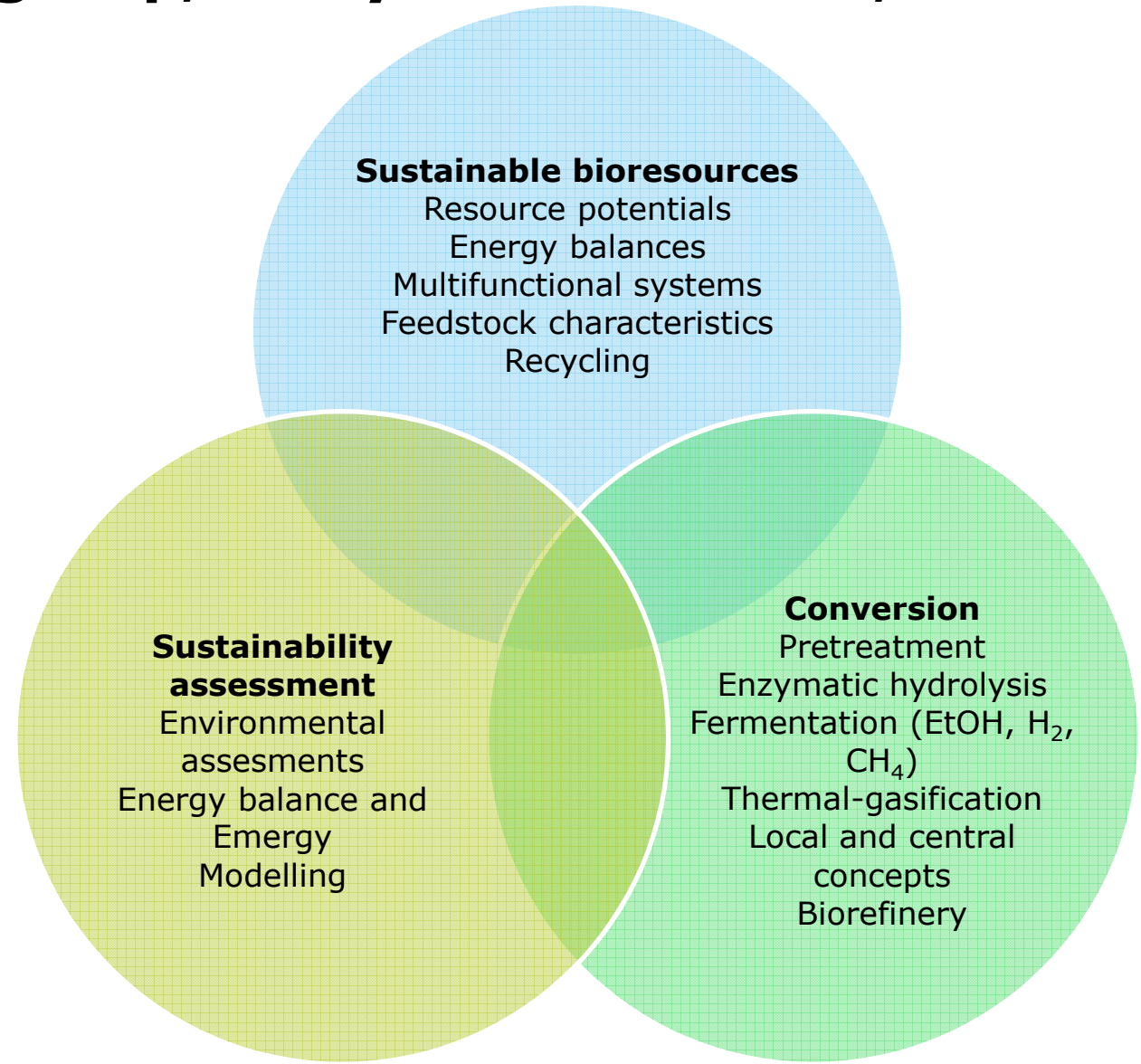

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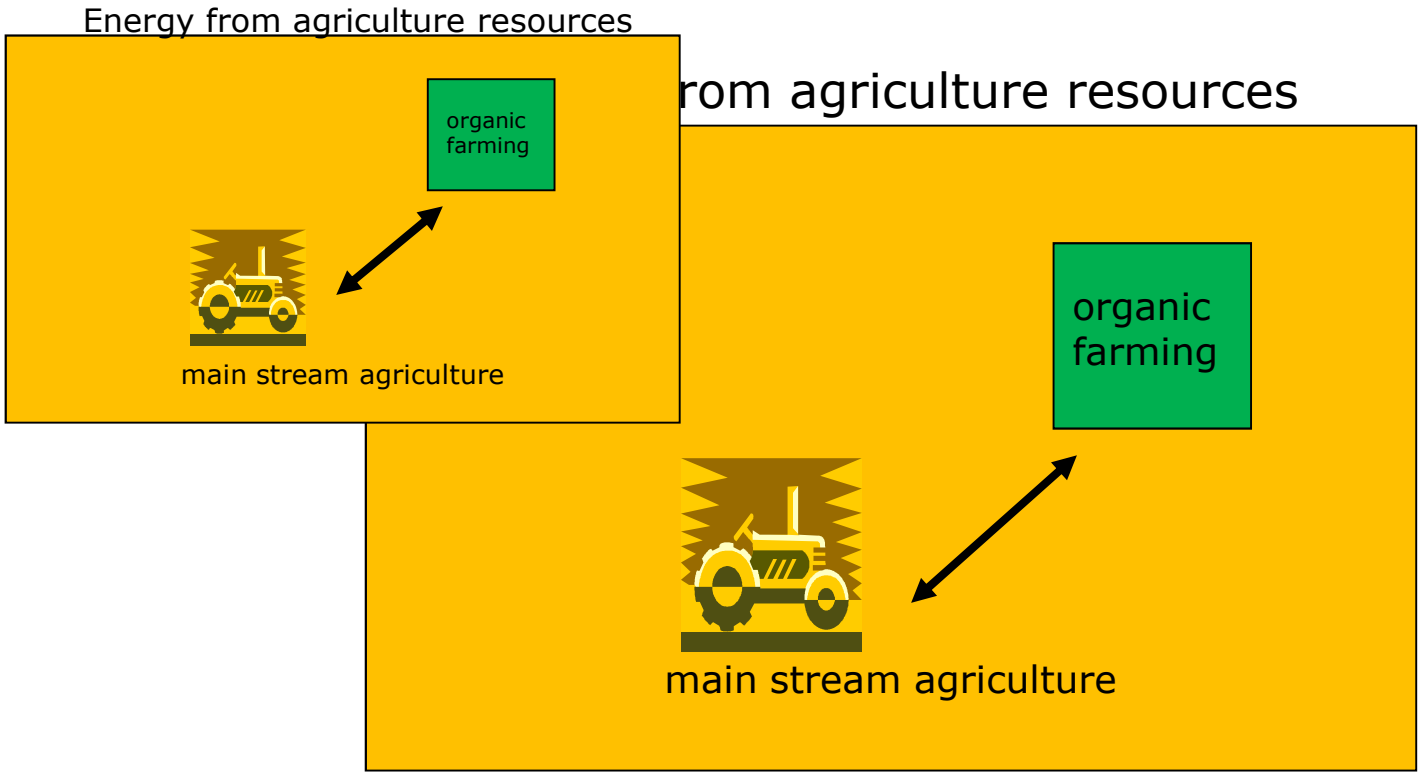

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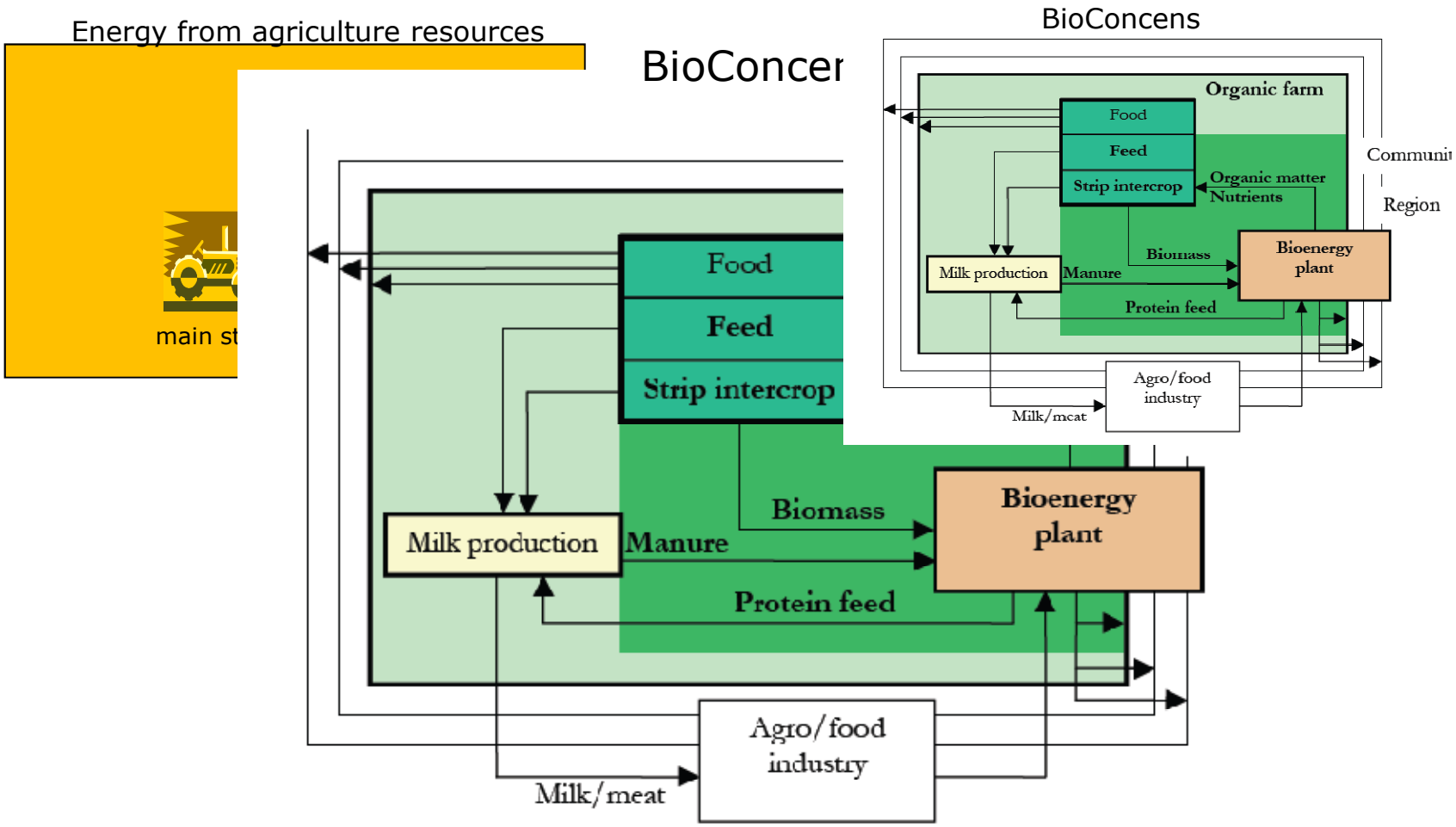

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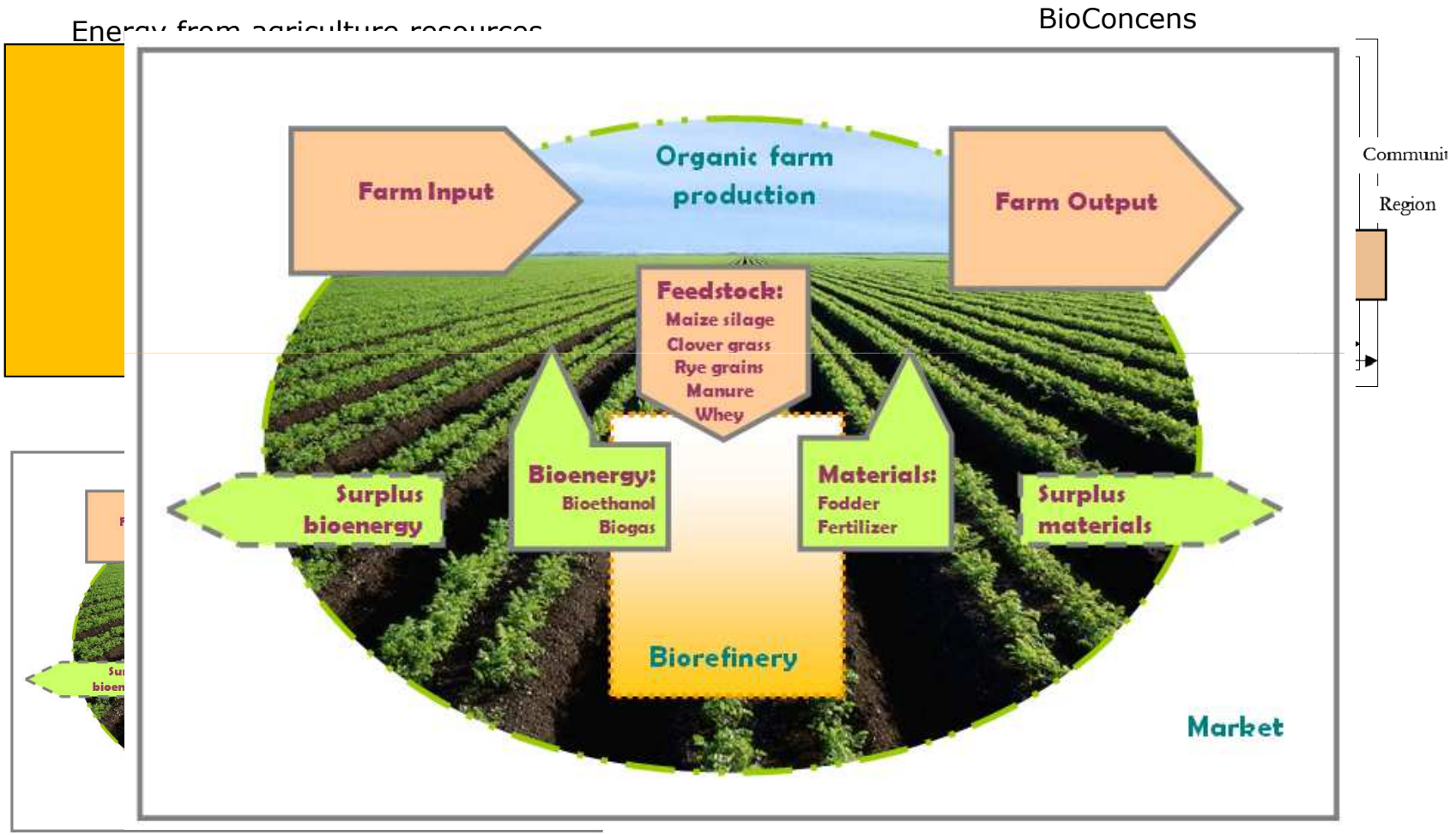

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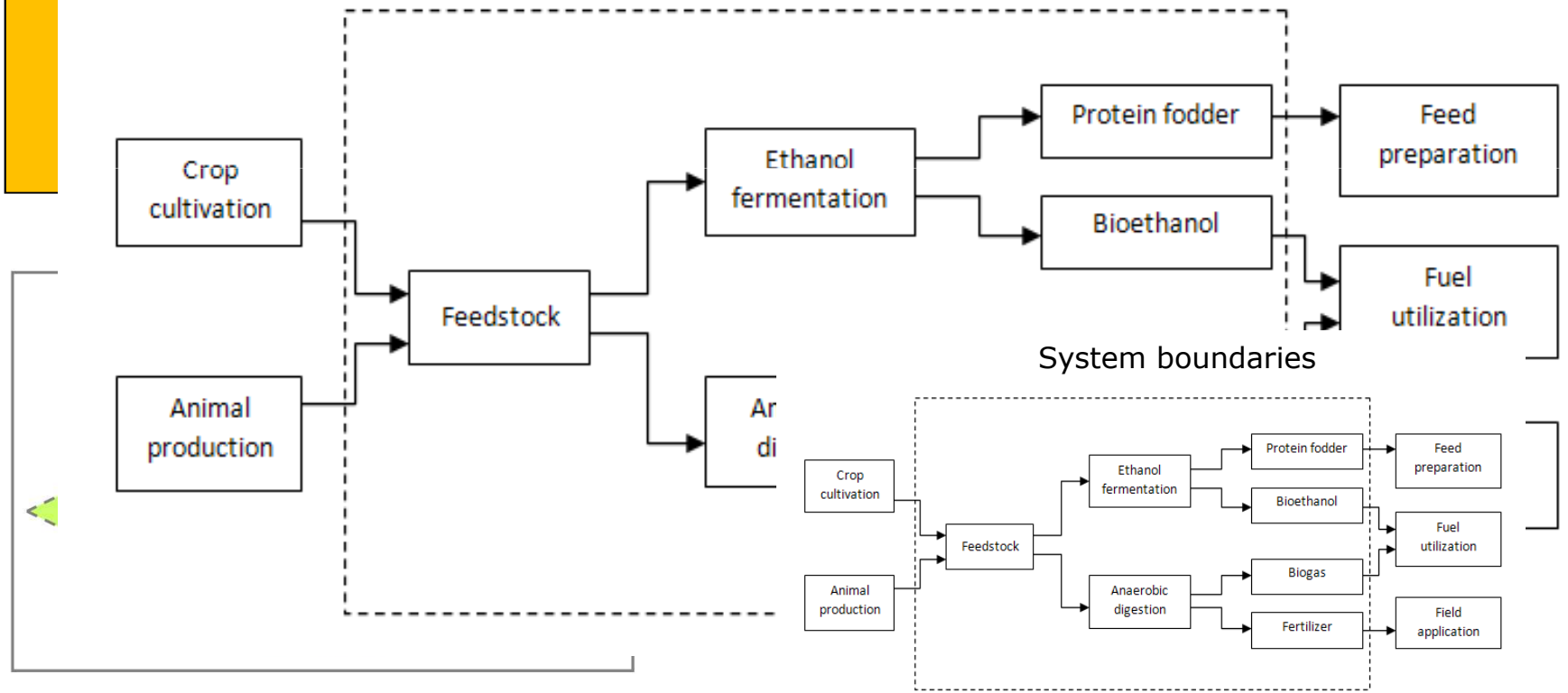
Energy from agriculture resources

BioConcens

System boundaries



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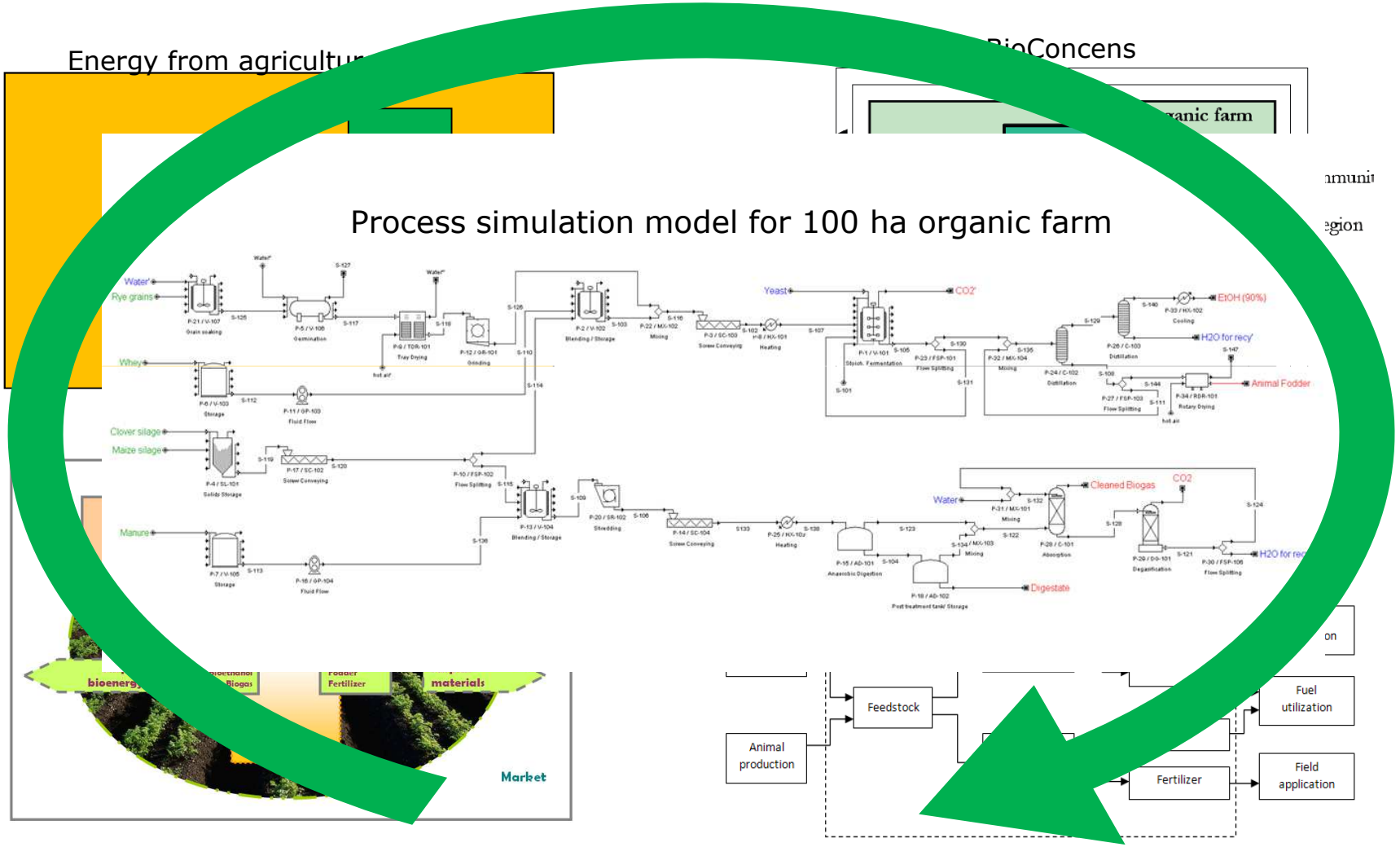

On-farm biorefinery products

Ethanol production	
Rye grains (15% water)	28 032 kg/year
Whey (93% water)	28 032 kg/year
Ethanol (90.8%)	12 071 L/year
Effluent from ethanol process after drying (17% water) (for animal feed)	10 416 L/year

Anaerobic Digestion	
Clover grass silage (29% water)	30 660 kg/year
Maize silage (70% water)	30 660 kg/year
Cattle manure (95% water)	100 740 kg/year
Upgraded biogas (97.8% methane)	6 693 m^3/year
Digestate (83.2% water) (containing micro- and macro nutrients for soil fertilization)	155 446 kg/year

Conclusions

Assuming yields:	rye grain:	4.0 tDM/ha
	clover grass:	10.0 tDM/ha
	maize:	11.0 tDM/ha
	manure:	21.9 t/year/cow
	whey:	4.5 t/year/cow

The land requirements are:

6 ha of rye and 7 milking cows for EtOH production

2.2 ha clover grass, 0.9 ha maize and 5 cows for biogas

There is a question if it could be economical feasible to establish such a small on-farm bioenergy production facility or it rather would be better to build centralized biorefinery to join around 10 organic farms for the area of 1000 ha.

Further optimization of the simulation

- The combination of raw materials can be further optimized and adjust to the specific organic farm
- Heat recirculation was not modeled but it is important factor to improve economy of the on-farm biorefinery
- Further optimization of recirculation of process water will be carried on
- Second generation ethanol production from lignocellulosic materials should be investigated as well
- Process simulation model for 1000 ha

photo: www.siteselection.com